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# Mapping the COVID-19 Anti-Vaccination Communities on Facebook in Czechia

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**Abstract:** The COVID-19 pandemic has led to a rise in opposition to vaccination, hindering herd immunity. As social media play a major role in the formation of anti-vaccination communities, it is critical to monitor the discourse on the platforms to effectively counter the negative sentiment and encourage people to vaccinate. This study employs computational content analysis, specifically topic modeling and time series analysis, to monitor the COVID-19 anti-vaccination communities on Facebook in Czechia. The analysis generated 18 topics with politics, governance, and international affairs being the most discussed, and only five dealt with issues directly related to COVID-19. Discussions about information and its credibility were prevalent, and members of these anti-vaccination communities relied heavily on social media content and conspiracy websites as sources of information, while neglecting scientific resources. The study highlights the need for ongoing monitoring of anti-vaccination communities on social media and the development of effective communication strategies to promote vaccination.

**Keywords:** COVID-19, Czechia, anti-vaccination, Facebook, topic modeling

## INTRODUCTION

Although vaccines are considered one of the greatest inventions in history, having saved the lives of countless people, public skepticism toward vaccination has been increasing steadily in recent years, and the COVID-19 pandemic further accelerated the process (Benoit & Mauldin, 2021). While vaccine hesitancy has been documented since the very first vaccinations (e.g., Hussain et al., 2018; Kinch, 2019), the internet and particularly social media arguably further exacerbated the problem (Kata, 2010). Since online information can significantly shape

health-related attitudes and behavior (Gray et al., 2005; Vaterlaus et al., 2015; Witteman & Zikmund-Fisher, 2012) there is a need for continuous examination of online vaccine-related narratives. Furthermore, Tomeny and colleagues (2017) argue that monitoring the contemporary vaccination discourse on social media is essential to successfully counter the anti-vaccination sentiment and promote vaccination. This need is further emphasized by the new wave of anti-vaccination sentiment brought about by the COVID-19 pandemic.

This study addresses this gap by uncovering the topics discussed by opponents of the COVID-19 vaccination on Facebook in Czechia, using methods of computational content analysis. Czechia has been widely labeled as one of the countries most affected by the pandemic (Kottasová, 2021). With two-thirds of its citizens fully vaccinated against COVID-19, Czechia lies between the Western European countries with high vaccination rates (70-80%) and the Central and Eastern Europe ones with much lower rates ranging from 30% in Bulgaria to a high of 65% in both Czechia and Hungary (ECDC, 2022). The findings of this study can potentially aid public health agencies in the development of effective campaigns endorsing vaccination. Moreover, as this study also tracks the changes in activity of these communities over time, the results could assist agencies in predicting events that cause activity spikes, further aiding in the development of strategies to counter increased anti-vaccination sentiment (Lyu et al., 2021).

## VACCINE HESITANCY

MacDonald (2015) defines *vaccine hesitancy* as a variety of attitudes ranging from a mere delay to upfront refusal of vaccine uptake. Generally, the gravest concerns of people holding these attitudes, often referred to as “anti-vaxxers” (Benoit & Mauldin, 2021), are about safety and possible side-effects (Ali & Celentano, 2017). Although a certain level of reluctance to the act of inoculation has been present since the start of the inoculation programmes (e.g., Hussain et al., 2018; Kinch, 2019), the boom of the modern anti-vaccination movement is often linked to the infamous research by Wakefield et al. (1998), who linked vaccination to autism. Although this claim has now been long disputed and the above cited paper retracted, many anti-vaccination activists still base their arguments on this work (Hussain et al., 2018) and meanwhile the WHO has listed vaccine hesitancy as one of the greatest threats to global health (WHO, 2019). Arguably, the threat has been even more enhanced with the advent of COVID-19 and the associated new wave of vaccine resistance. The number of people who deny receiving the recommended vaccination is constantly increasing, posing a progressively greater threat to public health and safety (Benoit & Mauldin, 2021). The most frequently reported reasons for COVID-19 vaccine refusal are safety concerns,

uncertainty caused by rapid development of the vaccines, and fear of side effects (Dror et al. 2020; Lin et al., 2020).

The relevance of vaccine hesitancy and the need to address it is further emphasized by the fact that future pandemics comparable to COVID-19 are relatively likely, and the probability of their occurrence is gradually increasing (Marani et al., 2021). While most people would still get recommended vaccinations and can thus be considered supporters of the practice (Burki, 2020), it is still essential to reach certain levels of vaccination rates to create and maintain herd immunity.

## **HEALTH-RELATED MISINFORMATION AND THE ANTI-VACCINATION MOVEMENT ON SOCIAL MEDIA**

Trust in traditional information sources is declining (Sylvia Chou & Gaysynsky, 2020), leading to an increased reliance on online channels for health information (e.g., Chou et al., 2018; Zhao & Zhang, 2017). However, health-related information found online often lack veracity and quality (Benoit & Mauldin, 2021; Zhao & Zhang, 2017). Social media is particularly problematic with exchanges of information happening in real-time with very little or no supervision (Chou et al., 2018; Witteman & Zikmund-Fisher, 2012). Without a vigilant approach and constant verification, users can easily fall victim to the spread of health misinformation on social media. Many users view the internet as a reliable source of health-related advice, which could lead to various health risks (Cavallo et al., 2014) as online information can shape health-related attitudes and behavior (Gray et al., 2005; Vaterlaus et al., 2015) and the overall health literacy of the population (Benoit & Mauldin, 2021).

Generally, research identifies two main factors contributing to social media's success in polarizing public opinion on vaccination. The first factor is psychological, as individuals tend to seek out and interact with content that aligns with their existing beliefs and attitudes, leading to confirmation and availability biases (Klapper, 1960; Spohr, 2017; Stroud, 2007). Secondly, the personalization algorithms used by social media platforms lead to echo chambers, in which users are surrounded by like-minded individuals and receive, almost exclusively, information that reinforces their views (Pariser, 2011; Rader & Gray, 2015; Spohr, 2017; Witteman & Zikmund-Fisher, 2012).

The spread of false and misleading information is also a major feature of the anti-vaccination movement. Scholars agree that the internet, and social media in particular, provide fertile ground for the anti-vaccination sentiment to spread more widely than previously (Hoffman et al., 2019; Kata, 2012; Smith & Graham, 2019). Social media users prove this expansion by increasingly displaying skepticism towards vaccination (Hamplová, 2021). Notably, most of the vaccine-related

information on social media features negative sentiment towards vaccination (Benoit & Mauldin 2021). Moreover, anti-vaccination content generally receives higher user engagement on social media compared to content in favor of the practice (Basch & MacLean, 2019). Recently, the anti-vaccination pages on social networks have been estimated to have around 58 million followers worldwide (Armitage, 2021), and high social media dependency is considered one of the main predictors of COVID-19 vaccine avoidance (Allington et al., 2021). Despite the prominence of online anti-vaccination communities, their discourses and characteristics are still not well understood (Smith & Graham, 2019). Consequently, there is a critical need to monitor and understand anti-vaccination communities on social media and their discourses, to effectively counter anti-vaccination sentiment and promote vaccination (Smith & Graham, 2019; Tomeny et al., 2017; Wittman & Zikmund-Fisher, 2012). Based on these premises, we posed the first of three research questions (RQ):

**RQ1:** What are the topics discussed in Czech COVID-19 anti-vaccination communities on social media?

Anti-vaccination communities on social media have grown significantly since the beginning of the COVID-19 pandemic (Burki, 2020). Experts agree that opponents of vaccination managed to successfully seize the opportunity provided by the pandemic and further undermine the already fragile trust of society in vaccination (Hamplová, 2021). It has been debated that misinformation about COVID-19 vaccination is spread on the Czech internet mostly by websites and online users with connections to Russia (Hamplová, 2021). Recent evidence demonstrates that many of the most prominent Czech COVID-19 anti-vaccination communities shifted their focus to pro-Russian narratives immediately after the Russian invasion of Ukraine (Čeští Elfové, 2022b; ČTK, 2022b), which suggests that external events influenced the discourse of these communities. To delve deeper into this phenomenon and uncover the specific events and context that trigger such shifts, we pose the second of three research questions (RQ):

**RQ2:** How did the quantity of published posts and topics discussed in the Czech COVID-19 anti-vaccination communities on social media change over time?

Furthermore, members of anti-vaccination communities rarely use scientific sources to support their claims (Kata, 2012; Yiannakoulias et al., 2019), and a significant portion of online health-related information is often found to lack veracity and quality (Benoit & Mauldin, 2021; Zhao & Zhang, 2017). Generally, webpages promoting anti-vaccination views typically score lower on quality indicators compared to those advocating vaccination (Sak et al., 2015). Moreover, anti-vaccination comments on social media frequently feature conspiracy theories and misinformation, indicating a lack of trust in scientific sources (Klimiuk et al., 2021). Therefore, considering the evident disconnect between

the anti-vaccination discourse and scientific evidence, we argue that a thorough examination of information sources of the anti-vaccination communities is crucial. This approach is essential not only for understanding the persistence and spread of vaccination-related misinformation in these communities but also for developing effective strategies to counteract this trend. Additionally, the information sources of anti-vaccination communities in Czechia have not yet been empirically studied. Consequently, this forms the basis for the third of the three research questions:

**RQ3:** What informational sources are shared among the Czech COVID-19 anti-vaccination communities on social media?

## THE COVID-19 PANDEMIC IN CZECHIA

Czechia has been severely impacted by the COVID-19 pandemic with more than 42,000 deaths (Komenda et al., n.d.). Despite initial success in managing the spread of the virus, the healthcare system was overwhelmed as hospitalizations surged. As of December 2021, 19% of the Czech population was strongly against, and 6% doubtful of, the COVID-19 vaccines (STEM, 2021). The Czech government previously attempted to mandate COVID-19 vaccinations for citizens older than 60 years, but the decree was later repealed by the new government (Nohl, 2022). As of February 2023, 64.5% of Czechs were fully vaccinated. While since the beginning of 2022, the number of infected, hospitalized and deceased patients has been continuously declining (Our World in Data, n.d.), Skalický (2022) argues the necessity to continue to intensively promote COVID-19 vaccination and persuade the unvaccinated to change their stance.

## MATERIAL AND METHODS

To answer the research questions, a large-scale automated content analysis of publicly accessible Facebook posts was performed using the R programming language (R Core Team, 2022). Subsequently, the outputs of the computational content analysis were qualitatively interpreted (Günther & Quandt, 2015).

Facebook was selected as the most used social network in Czechia, with more than 50% of the population using it (StatCounter Global Stats, 2022). Data was accessed via CrowdTangle<sup>1</sup>. The purpose of the study was to analyze the characteristics of the social media communities that are explicitly against COVID-19 vaccination. On Facebook, these communities usually gather

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<sup>1</sup> Meta's tool for analysis of social media data: <https://www.crowdtangle.com/>

in groups, or their members follow specific pages. To identify these communities, a Facebook search for public groups and pages was employed using keywords (in Czech) “*covid vaccination*”, “*COVID-19 vaccination*”, “*anti-vaccination*”, “*unvaccinated*”, “*against vaccination*”. Since anti-vaccination communities on social media are usually heavily interconnected (Smith & Graham, 2019), the snowball sampling method was also used to identify additional communities. The content of the identified communities was cursorily read to verify their resistance to COVID-19 vaccination. The study only selected relatively large groups with 3k minimum of members/followers (See Table 1).

Table 1: Analyzed Anti-vaccination Facebook Pages and Groups

Type of Facebook Account	Name in Czech	Name in English	Number of Followers/ Members (k = 1000)*
Page	Otevřeme Česko	Let's open the Czech Republic	89,7k
Page	Jana Peterková	Jana Peterková	43,8k
Page	Zdravé Fórum	<i>Health Forum</i>	28,7k
Group	Češi, táhněme za jeden provaz	Czechs, let's pull together	34,4k
Group	NEOČKOVANÍ CZ, SK	UNVACCINATED, CZ, SK	23,8k
Group	Na svobodu nám nesahejte! CZ SK jednotně!	Don't interfere with our freedom! CZ SK united	16,2k
Group	Neočkovaní	Unvaccinated	3,4k
Group	NEOČKOVANÍ	UNVACCINATED	3.k

Key: CZ—Czechia; SK—Slovakia; \*As of February 2022

Source: authors' own research

The study collected the textual data of all unique posts (n=433,191) in the selected groups and pages posted between 27.12.2020 and 23.2.2022. The beginning of the time frame corresponds to the day the COVID-19 vaccine was first administered in Czechia (Úřad vlády ČR, 2020).

## TOPIC MODELING

To answer RQ1 topic modeling approach was employed. The data was pre-processed (Günther & Quandt 2015) by removing digits, punctuation, symbols, URLs, stop words, and the most frequent Czech first names<sup>2</sup>. The texts were then tokenized, lemmatized, and underwent relative pruning. The applied pre-processing procedure was supported in the available literature (see Albalawi et al., 2020; Maier et al., 2020; Smith & Graham, 2019).

2 [https://krestnijmeno.prijmeni.cz/oblast/3000-ceska\\_republika/](https://krestnijmeno.prijmeni.cz/oblast/3000-ceska_republika/)

Silge and Robinson (2017) define topic modeling as „a statistical method for identifying words in a corpus of documents that tend to co-occur together and as a result share some sort of semantic relationship” (p. 211). Therefore, the term *topic* in this sense refers to a set of words that are semantically linked based on their co-occurrence in text. The use of topic modeling has been introduced to identify topics „hidden” in large unstructured datasets (Albalawi et al., 2020; Günther & Quandt, 2015).

Roberts et al. (2014) introduced Structural Topic Models (STM) with the corresponding *stm* package (Roberts et al., 2019). STM differs from commonly used Latent Dirichlet Allocation (LDA) (Albalawi et al., 2020; Jockers & Thalken, 2020; Silge & Robinson, 2017) by enabling inclusion of document-level covariates (metadata) in model training, thereby enhancing topic interpretability and inference (Roberts et al., 2019). This approach was selected for its ability to analyze the relationship between topics and time and its effectiveness with non-English social media data (Lucas et al., 2015).

When running an STM model, the number of  $k$  topics is not a priori known, as the algorithm itself cannot infer the number of topics from the presented data (Jockers & Thalken, 2020; Roberts et al., 2019, 2014). Based on recommendations of Silge (2018) and Roberts et al. (2019), models with values for  $k$  ranging from 10 to 50 were trained, and the held-out likelihood, semantic coherence, and residual dispersion were calculated. Results suggested the optimal number of  $k$  topics to be 18 to 19. Semantic coherence and exclusivity were also calculated, with topics 18 to 20 presenting an optimal trade-off between the two measures. Therefore, the *stm* model was fitted with 18 to 19 topics. The goal was to achieve the most meaningful and interpretable results. Junk terms were manually removed during this process, resulting in a final determined number of 18 topics, providing valuable outputs for further interpretation.

Once the model was fitted, the top terms for each topic based on their probability of appearing within the topic were investigated (per-topic-per-word probabilities *beta*). Additionally, *gamma* probabilities, indicating the per-document-per-topic probability (Silge and Robinson 2017), were generated, and the messages with the highest probability for each topic were checked. Based on the outputs of these steps, each topic was qualitatively labeled. The resulting labels for each topic are shown in Table 2.

The applied STM model included a topical prevalence parameter, which indicates to what extent a topic contributes to a document (Roberts et al., 2019). In this case the date an analyzed Facebook post was shared was selected as covariate, and the relationship between topics and metadata was visualized.

In addition, changes in the number of published posts were analyzed and visualized using the *dplyr* (Wickham et al., 2022) and *ggplot2* packages (Wickham, 2016), with dates of high activity examined in news media archives for context.

**Table 2: Topic Labels**

Topic Number	Topic Title
1	Patriotism and the fight for truth
2	Legislature and government measures
3	COVID-19 testing
4	Society and media
5	Contemporary world affairs
6	Compulsory vaccination
7	Demonstrations for freedom
8	Distrust in politicians and their plan to instill fear in people
9	Protection of children: face masks and testing at school
10	The virus: numbers of infected, hospitalized and deceased patients
11	Sharing (medical) information
12	Junk topic
13	Knowing the truth
14	Safety and efficacy of the COVID-19 vaccines
15	Czech Republic as a state, international politics
16	Choosing what to believe
17	Finding answers and evidence
18	Recommending sources of information and highlighting the need to act

Source: authors' own research

## SHARED LINKS

In the specified time frame, 143,896 unique URLs were shared 307,060 times. The URLs were manually assigned a website name and the overall sum of shares per website was calculated. Given the large data volume, only the names of the 327 most frequently shared pages were manually determined. The website names were obtained from the page source code, and the type of website was determined based on classification of the Foundation for Independent Journalism (Nadační fond nezávislé žurnalistiky, 2022) or self-description.

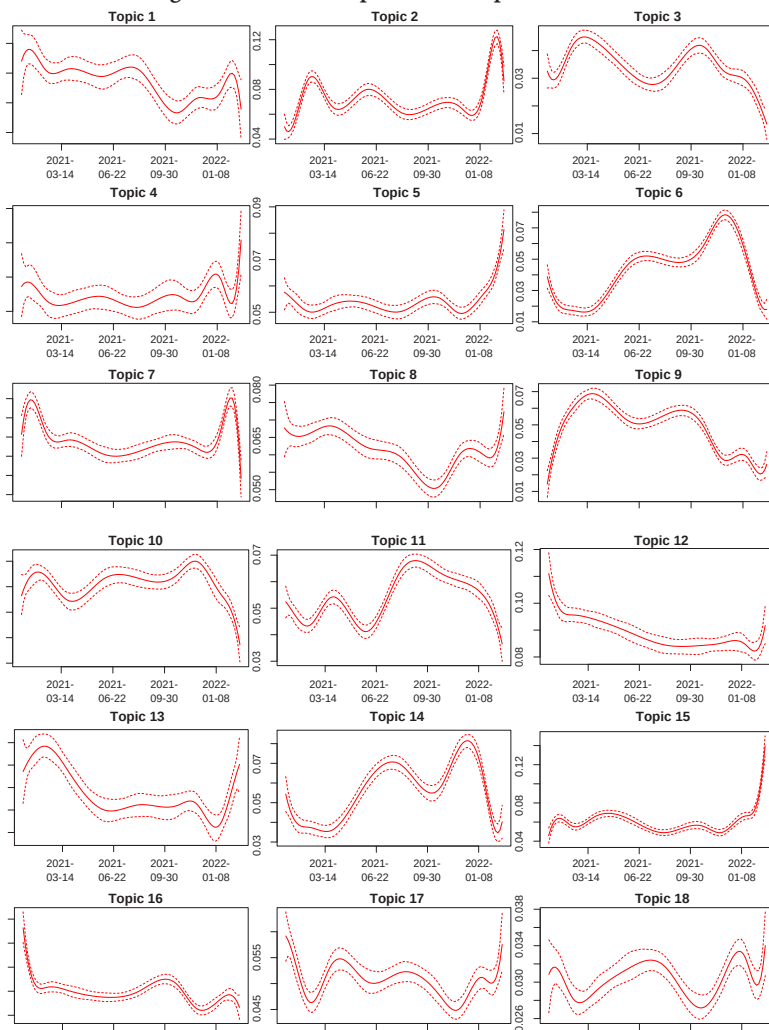


## RESULTS

### DISCUSSED TOPICS AND THEIR DEVELOPMENT OVER TIME

Each generated topic and its prevalence in the examined time period is discussed below (see Figure 1 for over time plots).

Figure 1: Relationship between Topics and Time



Source: authors' own research

**TOPIC 1: PATRIOTISM AND THE FIGHT FOR TRUTH**

The topic includes terms like “truth“, “to fight“, “power“, but also the Czech and Slovak flag emojis. Moreover, the Czech populist party Freedom and Direct Democracy (SPD), characterized by far-right nationalism, anti-establishment rhetoric, euroscepticism, and xenophobia (Kubát & Hartlínski, 2019), is mentioned. Support of the party has been associated with increased vulnerability to belief in COVID-19-related misinformation (Akademie věd České republiky, 2022). Discussion of this topic decreased steadily until the beginning of October 2021, which coincided with the Czech Parliamentary elections. The topic’s prevalence has been increasing since then, with a peak in February 2022 followed by a sharp decline.

**TOPIC 2: LEGISLATURE AND GOVERNMENT MEASURES**

This topic included terms related to the legislature, civic rights, anti-pandemic measures taken by the government, the Ministry of Health or the Chamber of Deputies. It is evident that two major peaks in salience occurred. First, the topic was discussed more than usual in February 2021 and then the highest peak can be seen in late January/early February 2022, which coincides with the Chamber of Deputies’ passage of a new pandemic law. The law faced strong opposition, with arguments centered around citizen freedom and rights restrictions (Pika & ČTK, 2022).

**TOPIC 3: COVID-19 TESTING**

This topic focused on COVID-19 tests, featuring terms like „test“, „virus“, „positive“, „PCR“, and „infected“. The prevalence of this topic over time features two peaks in March and November 2021. The first peak was during the strictest lockdown when regular COVID-19 tests were mandated for all employees and entrepreneurs (ČT, 2021). The second peak coincided with the introduction of measures that restricted access to certain public spaces for unvaccinated citizens (ČTK, 2021b).

**TOPIC 4: SOCIETY AND MEDIA**

This topic featured mostly terms that seemed to relate to the media and its effects on society, such as „society“, „system“, „message“, „medium“, „source“, or „problem“. The prevalence of this topic remained constant, except for a sharp rise at the end. The increased discussion of media and its effects on society occurred in February 2022, when the pandemic law was a topic of widespread discussion in the Czech media.

### **TOPIC 5: CONTEMPORARY WORLD AFFAIRS**

This topic contained terms like „war”, „money”, „state”, „change”, and „world”. Labelling was challenging due to its context-dependent nature and was thus informed by reports of the civic movement Čeští Elfové. This topic was discussed minimally during the observation period, except for January and February 2022. During this time, attention shifted away from COVID-19 to the situation in Ukraine. The monitored groups were supportive of Russia and critical of the Western response (Čeští Elfové, 2022a, 2022c).

### **TOPIC 6: COMPULSORY VACCINATION**

This topic focused on terms related to compulsory vaccination, possibly in relation to one’s job, featuring words like „vaccination”, „compulsory”, „to refuse”, „employee”, and „work”. Regular discussions on this topic began in spring 2021 and peaked in November/December 2021, when the Czech government announced its plan to mandate COVID-19 vaccination for citizens over 60 years and certain key infrastructure professions (ČTK, 2021a). However, this regulation was later repealed in January 2022 by the new government (Nohl, 2022).

### **TOPIC 7: DEMONSTRATIONS FOR FREEDOM**

This topic featured terms like „freedom”, „demonstration”, „police”, „support”, „event” or „fight”. Members of the analyzed communities probably not only discussed these events, but also promoted them, as the featured terms include names of places („Prague”, „square”, „town/city”) as well as time indicators („hour”). During the COVID-19 pandemic in Czechia, demonstrations and protests became frequent occurrences. That was also demonstrated by the prevalence of the topic in the analyzed time during which the demonstrations were highly debated. The first peak occurred in January 2021, with numerous protests held across the country against COVID-19 vaccination, anti-epidemic measures, and alleged restrictions on human rights and freedoms (ČRo, 2022). The second peak was in early February 2022, when protests were held against the adoption of the pandemic law (Pika & ČTK, 2022).

### **TOPIC 8: DISTRUST IN POLITICIANS AND THEIR PLAN TO INSTILL FEAR IN PEOPLE**

This topic featured words related to governance and politics such as „government” or „politician” but also terms that suggest an alleged plan of these entities to instill fear in people, for example „fear”, „need”, „plan”, „to believe” or „mankind”. The (offensive) term „sheep” is also present among the highest probability terms, used to label people who comply with COVID-19 measures and vaccination as blindly following without questioning. This topic’s prevalence

steadily declined from spring 2021 to its lowest point in October 2021, but has since been increasingly discussed again.

### **TOPIC 9: PROTECTION OF CHILDREN: FACE MASKS AND TESTING AT SCHOOLS**

This topic focuses on mandatory face masks and COVID-19 testing for children at schools. The community expressed displeasure with the implemented rules, and terms like „to protect”, „to defend”, and „health” were present. The topic was heavily discussed in April 2021 when children returned to school with regular testing and respiratory protection (ČRo, 2021b). The discussion slightly declined but peaked again in September 2021 with the new school year.

### **TOPIC 10: THE VIRUS: NUMBERS OF INFECTED, HOSPITALIZED AND DECEASED PATIENTS**

This topic featured terms like „covid”, „disease”, „hospital”, „case”, „patient” or „death”. The word „fraud” was also featured amongst the terms with high probability of appearing within the topic, arguably suggesting distrust in the officially reported COVID-19 statistics, and perhaps even in the existence of the virus or its severity. This topic remained prevalent throughout the analyzed period except for a slight decline in April 2021 possibly due to the government’s relaxation of anti-epidemic measures (ČT, 2021). A sharp decline occurred towards the end of 2021, possibly due to waning interest in COVID-19 and the emergence of other issues (e.g., the rising tensions between Russia and Ukraine) (Čeští Elfové, 2022c, 2022a).

### **TOPIC 11: SHARING MEDICAL INFORMATION**

This topic featured terms related to sharing medical information, such as „doctor”, „expert”, „pandemic”, „medical”, „to share” or „to spread”. Users were likely discussing and sharing videos or interviews of medical professionals. The topic peaked in April 2021 before declining in May. This period correlates with the so-called “hard lockdown” (ČT, 2021). It started to escalate again in late August and early September 2021 and has been slowly declining since then.

### **TOPIC 12: JUNK TOPIC**

This topic was determined to be a junk topic as it fulfilled the conditions stated by Nikolenko et al. (2016).

### **TOPIC 13: KNOWING THE TRUTH**

This topic features terms like „to know”, „to see”, „fact”, „really”, or „clear”, indicating discussions about knowing and realizing what is true or what is not. The discussion of this topic was the highest in February/March 2021 when the vaccination of the elderly and medical staff took place and was followed by the

hard lockdown (MZČR, n.d.). Thereafter, the topic became less and less discussed reaching its lowest prevalence point at the end of the year, followed by a sharp increase in January 2022. This again correlates with the anti-vaccination communities turning their attention to the rising tensions between Russia and Ukraine.

#### **TOPIC 14: SAFETY AND EFFICACY OF THE COVID-19 VACCINES**

This topic focused on COVID-19 vaccines' safety and efficacy, indicated by terms like „vaccine”, „immunity”, „safety”, „effect”, and „Pfizer”. Discussions peaked during summer 2021 as vaccination became available to different age groups, arguably leading to perceived pressure to vaccinate. However, the topic was most discussed in November/December 2021 after the government announced new measures to prevent unvaccinated individuals from accessing restaurants and other public spaces (ČTK, 2021b).

#### **TOPIC 15: CZECH REPUBLIC AS A STATE, INTERNATIONAL POLITICS**

This topic focused on the Czech Republic as a state and international politics, with keywords including „state”, „Czech”, „citizen”, and „EU”, „USA”, „Russia”. The topic gained attention in February 2022 when the anti-vaccination communities shifted their focus from COVID-19 to international affairs, particularly the conflict between Russia and Ukraine.

#### **TOPIC 16: CHOOSING WHAT TO BELIEVE**

This topic featured keywords such as „group”, „to think”, „choice”, „to vote/to choose”, „opinion”, „choice” or „attention/beware”, possibly relating to the discussion about choosing what to believe. The topic was most frequently discussed at the beginning of 2021 and remained constant for the rest of the observed period, except for a drop in November/December 2021, when a steep increase in prevalence was detected for other topics leading to the neglect of this one.

#### **TOPIC 17: FINDING ANSWERS AND EVIDENCE**

This topic included terms such as „time”, „question”, „to exist”, „to find”, „to prove”, „answer” or „proof/evidence”. The phrase stating that time will tell where the truth lies was common. In terms of the prevalence of the topic, fluctuations occurred all throughout the observed period. There were two substantial drops, in February/March 2021 and then in November of the same year, while the topic was the most prevalent in December 2021 and February 2022.

## TOPIC 18: RECOMMENDING SOURCES OF INFORMATION AND HIGHLIGHTING THE NEED TO ACT

The final topic included terms such as „information”, „need”, „link”, „to recommend”, „page”, „necessary”, or „to act”. As for the previous topic, fluctuations in the prevalence were relatively frequent. The first major drop occurred in February/March 2021, when the strictest lockdown took place in Czechia (MZČR, n.d.). Hence, other topics were the focus of discussions of anti-vaccination communities. The topic was then heavily discussed over the summer 2021 until dropping again in October when the elections to the Chamber of Deputies of the Parliament of the Czech Republic 2021 were held (ČSÚ, 2021).

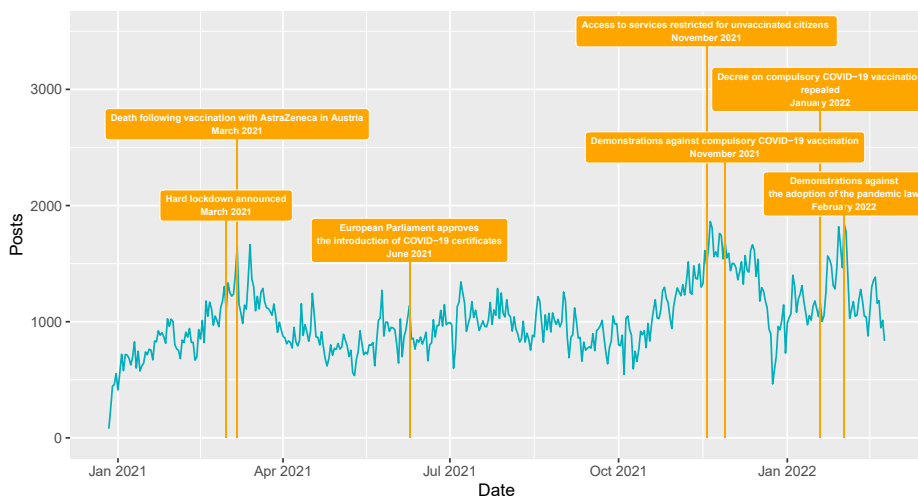
The identified topics fall into thematic clusters. The first cluster revolves around government and health policies, covering legislative measures, compulsory vaccination, and protection of children. These discussions highlight the tension between public health policies and perceived infringement on personal freedoms. The second cluster focuses on public perception and societal responses, including media influence, freedom demonstrations, and distrust in politicians, reflecting skepticism towards official narratives. These topics' prevalence fluctuates with key events like elections, legislative changes, or international events, showing a reactive, evolving discourse. The third cluster centers on information dissemination and truth-seeking, involving topics on sharing medical information and seeking alternative explanations and evidence, indicating a community questioning mainstream narratives and seeking alternative explanations.

## DEVELOPMENT OF FACEBOOK ACTIVITY OVER TIME

The number of posts in the Facebook communities over time are shown in Figure 2.

The graph indicates that peaks in activity can be linked to specific pandemic-related events in Czechia. Two time periods stood out. The first occurred in March 2021 when the strictest lockdown of the pandemic began in Czechia and health complications associated with the AstraZeneca vaccine were reported (ČRo, 2021a). The second was in autumn 2021 when the government announced restrictions for unvaccinated citizens, regular testing for unvaccinated employees, and prepared a law on compulsory COVID-19 vaccination (ČTK, 2021a, 2021b). A sharp drop occurred in December 2021, followed by a peak in February 2022 when the government's amendment of the pandemic law was debated by the Chamber of Deputies, accompanied by large demonstrations (Pika & ČTK, 2022).

Figure 2: Relationship between Number of Published Posts and Time



Source: authors' own research

## SHARED SOURCES OF INFORMATION

To address RQ3, we identified the 20 most shared websites, their types, and share proportions (see Table 3). The majority of shared links (72.089%) featured the Facebook domain, followed by YouTube at 4.222%. Eight of the top 20 shared websites were classified as news websites and another eight as conspiracy or anti-system servers. One of these, Aeronet, appeared on the list of misinformation websites, to which access was blocked in February 2022 following governmental recommendation due to concerns about its potential impact on Czech national security amid the Russian invasion of Ukraine (ČTK, 2022a).

Table 3: The 20 Most Shared Websites in the Analyzed Communities

Website Name	Website Type	N	%
Facebook	Social media	221357	72.089%
YouTube	Social media/Video platform	12965	4.222%
Novinky.cz	News	4607	1.500%
Parlamentní listy	News	3894	1.268%
Seznam Zprávy	News	3485	1.135%
CNN Prima News	News	3060	.997%
CZ24.NEWS	Conspiracy/antisystem	2448	.797%
Otevři svou mysl	Conspiracy/antisystem	2418	.787%
Aeronet	Conspiracy/antisystem	2177	.709%

Website Name	Website Type	N	%
iDNES.cz	News	2133	.695%
Rumble	Social media/Video platform	1463	.476%
Aktuálně.cz	News	1235	.402%
Inadhled	Conspiracy/antisystem	1121	.365%
Echo24	News	1109	.361%
Badatel.net	Conspiracy/antisystem	1105	.360%
AC24	Conspiracy/antisystem	1003	.327%
Odysee	Social media/Video platform	803	.262%
TN.cz	News	799	.260%
tadesco.org	Conspiracy/antisystem	778	.253%
Volný Blok	Political party	750	.244%

Source: website type assigned based on Nadační fond nezávislé žurnalistiky (2022)

## DISCUSSION

This study investigated Facebook communities opposing COVID-19 vaccination in Czechia, focusing on discussed topics and frequently shared information sources over time.

In total, 18 topics were identified of which five related to information and its credibility (Topics 11, 13, 16, 17, 18). To some degree, these topics can be considered overlapping. Previous research suggests that questioning information credibility is the most common argument of both anti- and pro-vaccination communities in social media discussions (Jenkins & Moreno, 2020). Moreover, users' difficulty in assessing source credibility contributes to the widespread anti-vaccination sentiment on social media (Puri et al., 2020; Salmon et al., 2005). Surprisingly, only five topics dealt with issues directly related to COVID-19 as a disease, including testing, vaccination, health measures and infection rates (Topics 3, 6, 9, 10, 14). Many topics were related to politics, governance, and international affairs (Topics 1, 2, 5, 7, 8, 15), covering discussions on patriotism, citizenship, legislation, demonstrations, and international issues.

As for the development of the prevalence of the topics over time, most fluctuations can be explained by the contemporary context. Interestingly, despite the study's timeframe not covering Russia's invasion of Ukraine, discussions related to tensions between the countries were prominent from early 2022, with COVID-19 anti-vaccination communities turning their attentions away from vaccination and focusing on support of Russia (Čeští Elfové, 2022a, 2022b, 2022c; ČTK, 2022b)



Furthermore, this study showed that Facebook and, to a lesser extent, YouTube content was frequently shared in the COVID-19 anti-vaccination communities, echoing Chiou and Tucker's (2018) findings on childhood vaccine opponents. Relying on social media content as an information source was a concern due to the prevalence of unlabeled and unremoved misinformation (Center for Countering Digital Hate, 2020). Other common sources were news or conspiracy and anti-system websites, aligning with research indicating prominence of misinformation and conspiracy thinking in the anti-vaccination communities on social media (e.g., Kata, 2010; Smith & Graham, 2019). Additionally, our findings support existing research that online anti-vaccination content often lacks scientific backing, relying on anecdotal narratives instead (e.g., Kata, 2012; Yiannakoulias et al., 2019).

This study is not without limitations. First, the methodology only explores topics, not the specific arguments against vaccination. Moreover, although the terms within topics indicate the tonality in which the topic is discussed; it is not possible to reliably determine the attitudes of the discussants. Also, while computer-assisted text analysis is efficient and reliable, it has limitations, and results' validity can be questioned (Zamith & Lewis, 2015). The results of topic modeling were interpreted by a single researcher, which could introduce subjectivity. Despite these limitations, this study represents an important step in understanding social media's role in the anti-vaccination movement and offers detailed insights into Czechia's COVID-19 anti-vaccination Facebook communities.

The findings of this study present implications for various stakeholders, including public health agencies, policymakers, and social media platforms. Specifically, the insights revealed by this study could be leveraged to develop targeted communication strategies to counter misinformation and address the specific concerns prevalent in the anti-vaccination communities. Moreover, this research underscores the importance of developing more effective mechanisms for identifying and mitigating misinformation spread on social media.

In conclusion, this study provides detailed insights into the dynamics of Czech anti-vaccination social media communities during the COVID-19 pandemic. It advances the field by not only exploring the topics of discussion but also their evolution over time, offering a comprehensive overview of how these conversations shift in response to external events. Future research should aim for more advanced analysis of social media vaccination discourse and its impact on public health.

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